The CARRS-Q Advanced Driving Simulator

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CARRS-Q is a joint venture initiative of the Motor Accident Insurance Commission and Queensland University of Technology

www.carrsq.qut.edu.au

The CARRS-Q Advanced Driving Simulator

A brief description of its capabilities, uses, and operational issues

Acknowledgements

Australian Government

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THE UNIVERSITY OF QUEENSLAND

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Overview of the CARRS-Q Simulators

- CARRS-Q has two simulators: The Advanced Driving Simulator and a simpler “Desktop” simulator
- Both use the same research grade simulation software SCANeR, produced by French company OKTAL
- The Advanced Driving Simulator can integrate three aspects of simulation:
  - driving simulator
  - traffic simulator (links to AIMSUN)
  - control simulator

Advanced Driving Simulator

- Complete vehicle body (Holden VE Calais) as the simulator cabin
  - full integration of vehicle controls and instruments
  - all five seats available for multiple occupant studies
- 180 degrees of forward vision
  - provided by three 4m by 3m forward screens and projected images
- Simulated rear vision in centre and two side mirrors
  - provided by replacing the mirrors with similar sized LCD screens
- Simulated motion in three dimensions
  - provided by a REXROTH 6 Degrees of Freedom motion system
  - provides up to 700mm of motion in each direction, and up to 39 degrees of rotation in each direction

View of the Advanced Driving Simulator from the Control Room

Research Uses for Driver Behaviour

- Drivers, affected by:
  - drugs, alcohol, fatigue, prescription medication
  - injury (for example recovering whiplash affected drivers)
  - behavioural (eg interactions with two wheelers)
- Different external environments:
  - road engineering (lane width, lane markings)
  - road infrastructure, such as railway crossing design
- Different vehicle environments:
  - driver distraction or behaviour change by:
    - in car devices (eg mobile phones, GPS)
    - in car occupants
    - driver aids (eg collision detection devices, other ITS devices)

“Simulator Sickness”

- Nausea induced by simulation is a well known issue
- The research literature, and our experience, shows peripheral vision and motion are major influences
  - more than about 140 degrees of forward vision are required for peripheral vision cues to indicate expected motion for most people
  - no participants have experienced nausea in our “desktop” simulator with about 50 degrees of forward vision (1.6m screen at 1.8m distance)
  - with the 180 degree front field of view of the Advanced Driving Simulator, operation without motion is possible, but is the most nauseating
- For the Advanced Driving Simulator, sharp corners (for example 90 degree bends) produce the greatest discrepancy between the seen and felt motions
- Responses vary greatly between individuals, but even with optimum tuning and subject screening approximately 10% of participants are experiencing sufficient nausea to abort simulation

Driver Behaviour: familiarisation

- Despite the realistic simulated environment, participants still require some time to adjust to the simulator and its characteristics:
  - steering wheel and brake pedal feel
  - accelerator and braking response
  - characteristics of the simulated vision and motion
- The effects of driver unfamiliarity with the simulator are largely eliminated by:
  - including a "familiarisation" drive of around 5-10 minutes before the research scenarios
  - the “familiarisation” drive includes objects and activities that will be included in the research scenarios, for example:
    - other road users (cars, pedestrians, cyclists etc)
    - driving activities, such as overtaking
    - road infrastructure (signage, traffic lights etc)

Driver Behaviour: research setup

- Individual participants display a range of driving styles, from cautious to aggressive
- It can be challenging to design simulation scenarios that cope with a wide range of driving styles
  - eg a critical event setup that works well if the driver is following the speed limit may not work if the participant is driving too fast or too slow
- Multiple test drives of new simulation scenarios are desirable, by persons unfamiliar with the research details
- There are very few instances of drivers not becoming immersed in the simulation and driving in a manner that they would not normally use

Driver Guidance: path

- How to guide the driver through the simulated road network?
- Should seem natural to the driver so as not to influence driver behaviour
- Methods that we have used and that are effective are:
  - voice instructions ("GPS like")
  - road signage
  - both voice and signage at the same time has proved most effective

Driver Guidance: behaviour

- Guidance can also be used to influence driver behaviour:
  - which lane to use
  - what speed to be using
- Voice commands are effective, but some drivers report feeling of being controlled
- Road signage (eg speed limit signs) can be included as frequently as desired and are more natural, but can be overlooked
- Some studies are using custom signs for specific tasks

Summary

- The Advanced Driving Simulator is proving an effective tool for a range of research studies
- With experience in operation, the issues of; simulator sickness, driver behaviour and driver guidance, are being effectively addressed
- Most drivers become well immersed in the simulation, as indicated by these anecdotes:
  - one participant felt that they could not stop their simulated drive without driving back to the starting point
  - one participant started to become anxious that they were holding up following (simulated) traffic
  - one participant verbally abused the driver of the computer controlled vehicle in front of him

Questions?

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http://www.carrsq.qut.edu.au/simulator/

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Mark your Diaries!

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